COLORED STONES

ASSIGNMENT 21

QUARTZ

IDENTIFICATION, PRODUCTION, MARKETING, BUYING

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I. INTRODUCTION

Quartz is the most common single mineral in the earth's crust. It touches the daily life of everyone. It is used in electronics as a frequency standard and, when fused (melted to a glass), for optical instruments, eye glasses, porcelain and other products. In the form of minute dust particles in the air, it scratches other gemstones of lesser hardness and, to some extent, even the various quartz gems themselves. It is found in a greater variety of forms and modes of occurrence than any other mineral. As a gem, quartz is also the most commonly used of the minerals.

Quartz in its various forms has attracted the attention of man from the earliest times. The colorless, transparent variety was known to the Greeks as "krystallos," meaning "clear ice," for they believed that the mineral was ice in a permanent, solidified form. The name quartz is an old German mining term of unknown meaning that has been in general use in all languages since the sixteenth century.

The Chinese believed that rock crystal quenched thirst when held in the mouth. It was used as a gazing globe, and the future was foretold from the images that were invoked by the magicians. This belief, which was almost universal, is still held in certain circles in our own time and nation. The Indians of North America and many tribes of South America had the same idea: a spirit dwelled within the crystal and was believed to speak to the medicine doctors or prophets of the fate of the seeker.

The modern commercial tendency to misrepresent almost every commodity, unless it may result in a jail sentence, has so debased the word crystal that even our modern dictionaries permit its use for flint glass. It has degenerated until it is used principally to refer to glass, and even otherwise honest jewelers are sometimes guilty of placing glass beads or glass tableware in their windows with the sign "genuine crystal." No gemologist should ever use the term crystal except to refer to the natural external form of a crystalline mineral, to the internal arrangement of the structure of crystalline minerals, or to geniune rock crystal.

Amethyst, the February birthstone and probably the most valuable member of the quartz family, derives its name from a Greek word meaning "not to intoxicate." Its reputed power to cure or prevent drunkenness stems from an ancient Greek myth that tells of the god Bacchus who, offended by some neglect of the goddess Diana, determined to avenge himself by declaring that the first person he met would be devoured by tigers. The beautiful maiden Amethyst crossed his path. As the ferocious beasts sprang towards her, she called upon Diana for protection and was saved from a worse fate and turned to pure, clear stone. Upon seeing this, Bacchus became repentant and poured the juice of the grape over the petrified body, thus giving it its lovely purple hue. Because of this connection with the mythical Bacchus, the god of wine, it was long believed that wine drunk from an amethystine cup would prevent the drinker from losing his wits at banquets or drinking bouts.

Since it was one of the first gemstones used by man, many other legendary attributes were associated with amethyst. It was thought by our ancestors to quicken the intelligence and thus render the owner shrewd in business, to protect the soldier and give him victory, to aid hunters, to protect against contagious diseases, and to control evil thoughts. Catherine the Great was devoted to amethyst and sent thousands of workers to the Uralian mines to search for the stone. Her great collections of emeralds and amethysts were sold by the Russian Government about 1906, although many fine specimens of the latter still remain in the Soviet Treasury. A number of fine amethysts are in the Coronation regalia of England. The orb, a golden ball six inches in diameter that signifies the domination of the Christian religion over the world, contains a gloriously colored amethyst measuring one and one-half inches high. The King's scepter is studded with the gems. The coronet of the Prince of Wales is a circlet of pearls and fine amethysts. Today, amethyst-set rings are often worn by bishops of the Roman Catholic Church, and ceremonial wine is frequently drunk from goblets fashioned from this beautiful variety of quartz.

II. VARIETIES AND TRADE NAMES.

Pure quartz is an allochromatic stone; therefore, it is basically colorless. However, because of minute quantities of various impurities or radiation damage, it occurs in a wide array of colors.

A. Transparent.

1. Rock Crystal (Figure 1).

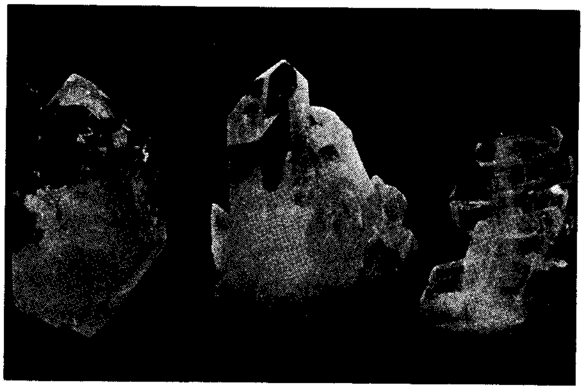


FIGURE 1

This variety in its purest form is colorless, transparent silicon dioxide (SiO_2). It enjoys great popularity in various areas of occurrence, such as Arkansas, for example, where it is known as "Arkansas diamond." Rock crystal has also masqueraded under the impressive but misleading names of "Herkimer diamond," "Arizona diamond," "Alaska diamond" and "Cornish diamond," to name a few. It has also been known as rhinestone, but its use under this name has been largely supplanted by colorless glass made more brilliant by the use of foil backing.

2. Iris, or Rainbow, Quartz.

This is rock crystal containing minute air- or liquid-filled fractures that produce iridescence by intereference of light. The fractures may occur in nature or be brought about artifically by heating and sudden cooling of the specimen. It is interesting to note that the Empress Josephine, wife of Napoleon, had a dazzling collection of jewelry made of iris quartz.

3. Rutilated Quartz, or Sagenite (Figure 2)

Another interesting variety of rock crystal is rutilated quartz, or sagenite, which is characterized by inclusions of reddish to golden needle-like crystals in the parent crystal. As the name implies, the usual mineral inclusion is rutile, although tourmaline, epidote, actinolite or others may also be encountered. Through the years this stone has had many interesting names, including the French "fleches d'amour" (Cupid's darts), Venus hair stone, Thetis hair stone, needle stone and sagenitic quartz. It is not used extensively as a gemstone in America.

4. Amethyst.

This best-known variety of quartz ranges in color from violet to red-purple and is frequently pale in tone. Deep, evenly colored specimens are particularly desirable. Uneven distribution of color, especially in the larger stones, is quite common. The most valuable hues, which range from deep purplish red to purple-red, are known in the trade as Uralian or Siberian amethysts. These names ori-ginally referred to geographical location, but since have become universally accept-ed as denoting quality rather than source.

Amethysts exhibit weak to distinct dichroism, and the more attractive specimens are usually distinctly dichroic. The color may sometimes be made more uniform by careful heating; however, strong heating or "burning" usually causes the stone to become yellowish brown, brownish or reddish brown, closely re-sembling the citrine variety. The color change so effected is permanent.

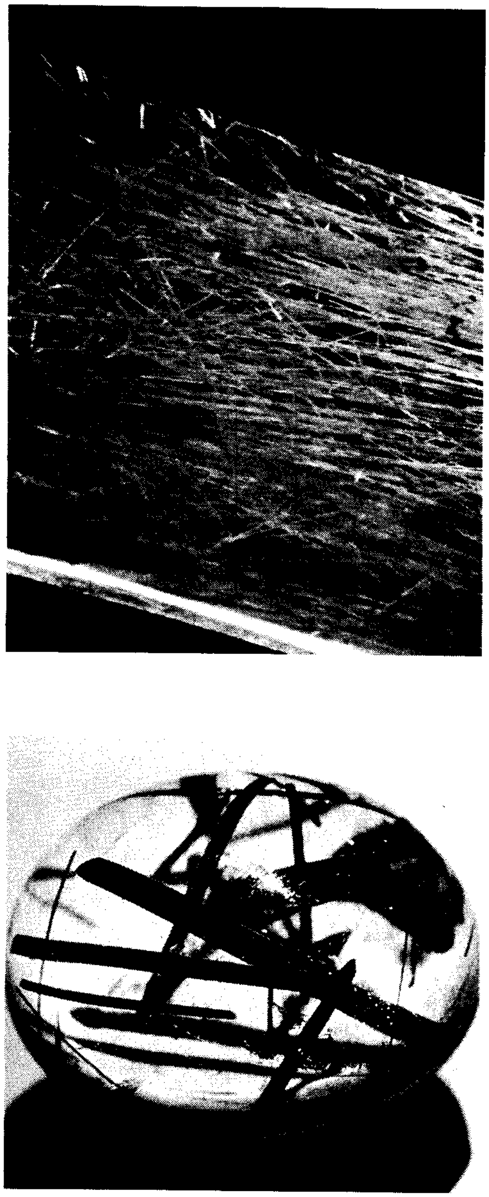


FIGURE 2

The oft-heard statement that amethyst "loses color" under artificial light refers to the fact that all bluish and violet colors lose color under the incandescent bulb or other sources of illumination that are themselves deficient in blue rays. Purplish and reddish-purple amethysts hold their color much better than violet stones, because the artificial light is not deficient in red rays.

5. Citrine, or Topaz-Quartz (Figure 3).

Naturally occurring yellow to red-orange to orange-brown varieties of quartz are known correctly either as citrine or topaz-quartz. However, these long-known gemstones, together with heat-treated poorer qualities of amethyst and other miscellaneous tones in this color range, are frequently sold in the trade as "topaz." "Spanish topaz" and "Saxon topaz" are other misleading names that are sometimes employed to describe the more desirable reddish to orange hues. Most citrine of better quality is nearly flawless. It has the added advantage of being both tougher and less expensive than topaz, but its texture and surface appearance lack the velvety quality of fine topaz. Citrine, which alternates with topaz as the birthstone for November, is adapted from the French word "citron," meaning "lemon."

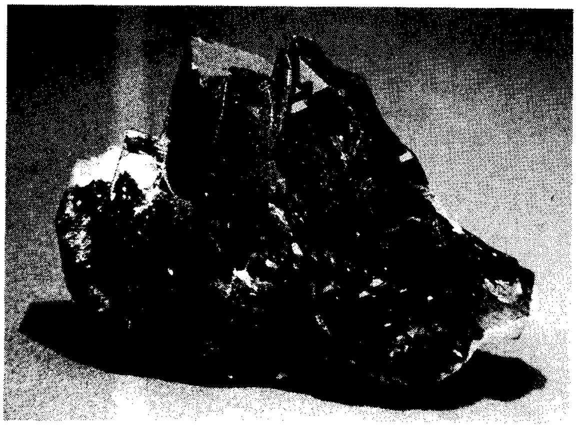


FIGURE 3

6. Smoky Quartz, or Cairngorm (Figure 4).

Perhaps the least appreciated but one of the most attractive members of the quartz family is the smoky-yellow to smoky-brown variety known as smoky quartz. This beautiful stone is also known as cairngorm, after the locality (Cairngorm Mountains) in which it became popular many years ago in Scotland and where it continues to be widely used and admired. This category of the quartz species also includes a nearly black color known as morion, which has served to some extent in mourning jewelry. Smoky quartz is incorrectly known and sold under other names, chief among which are "smoky topaz," "burnt topaz" and "Scotch topaz."

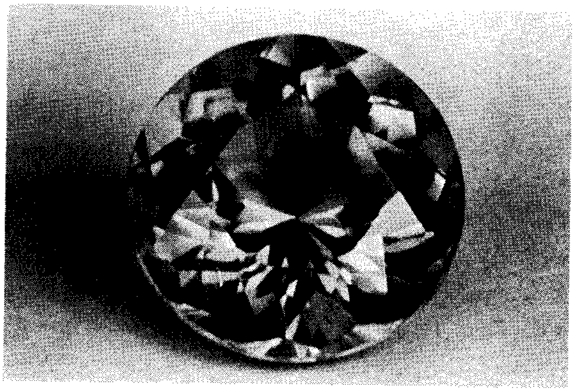


FIGURE 4

It is interesting to note that the color of this variety is thought to have been produced by radium emanations from the rock masses surrounding the original deposits of the smoky-quartz crystals. In fact, in this connection, it was noted in the Swiss Alps that the amount of radiation in these surrounding rock masses varied with the elevation. This variation produced corresponding differences in the colors or tones of the smoky-quartz deposits in the area with such consistency that experts could state with great accuracy at which elevation a given crystal had been found.

B. Semitransparent to Opaque.

1. Rose Quartz.

This semitransparent to translucent variety occurs in various tones and intensities of red, ranging from pink to rose red to pale rose. Individual crystals of sufficient size to be identifiable as such are practically unknown. Rose quartz exists almost exclusively in the massive form; i.e., internally crystalline but without the clearly defined external form that is so common in rock crystal.

Analine dyes are sometimes employed to produce the deeper shades or more uniform colors in low-quality material. The dyed stones usually have a somewhat unnatural appearance and tend to fade and lose color more rapidly than the genuine. Asterism is sometimes exhibited, but asteriated specimens are not common in the trade today, having been largely superseded by the Linde synthetic star stones.

2. Aventurine Quartz.

The appearance of this variety is characterized by a spangled or glittery aventurescent effect that is observed when the stone is rotated in reflected light. This phenomenon is caused by separate reflections from included flakes or scales of a different mineral. The body mass may vary considerably in color, including grayish, yellowish and brownish; however, that most commonly encountered in jewelry is green. It resembles Wyoming nephrite jade in appearance.

Aventurine quartz is usually quartzite, the metamorphosed sandstone in which the spaces between sand grains have been filled. Most of the space is filled by quartz, but other minerals may be present, often adding color. The typical included minerals are mica; fuchsite (FOOK-site), which is a green chromium mica; hematite; and goethite (GAY-tite). The inclusion of each of these minerals produces an aventurescence of somewhat different appearance: mica creates a silvery, brassy or golden glitter; hematite or goethite causes a reddish spangled effect; and fuchsite produces a greenish aventurescence. An imitation aventurine known in the trade as "goldstone" is quite commonly encountered in the costume-jewelry field; it was described briefly in the feldspar assignment and will be discussed in detail in a later section of the course. It should be remembered that the term aventurine is common to both the albite feldspar species and the quartz variety; this distinction of classification should be observed carefully.

3. Dumortierite (du-MORE-tee-er-ite) Quartz.

This opaque, deep-blue or violet-blue to violet member of the quartz family is rarely encountered. It is basically a crystalline aggregate of quartz, profoundly colored by the obscure mineral dumortierite, which is a complex aluminum borosilicate. The typical dark-blue variety bears a close resemblance to lapis-lazuli and is incorrectly called "California lapis."

4. Milky Quartz.

Translucent to opaque massive material in the white to very light-gray color range is referred to as milky quartz. This variety is seldom used as a gemstone; however, when it occurs with native-gold inclusions, it is sometimes cut en cabochon or with a flat surface and called gold quartz.

5. Siderite (SID-er-ite), or Sapphire Quartz.

Another of the lesser-known varieties is the translucent indigo-blue type known variously as sapphire quartz, azure quartz or siderite. Its color is generally considered to be caused by the presence of unaltered crocidolite fibers. When these included fibers are oriented favorably and the stone is cut in the cabochon form, this mineral produces the chatoyant variety known as hawk's-eye or falcon's-eye.

C. Chatoyant and Asteriated.

1. Tiger's Eye

One of the best-known varieties of crystalline quartz is tiger's-eye, which may occur in colors from brownish yellow to brown and reddish, bluish, or even red. It varies from translucent to semi-translucent. This is an interesting mineral from a structural standpoint, since it is a true pseudomorph after crocidolite; i.e., the fibers of the original mineral, crocidolite, have been replaced entirely by small quartz crystals without disturbing the original shape of the fibers. The presence of this fibrous structure produces a silky sheen when the material is cut in flat slabs;

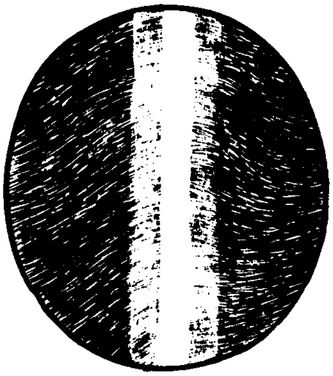


FIGURE 5

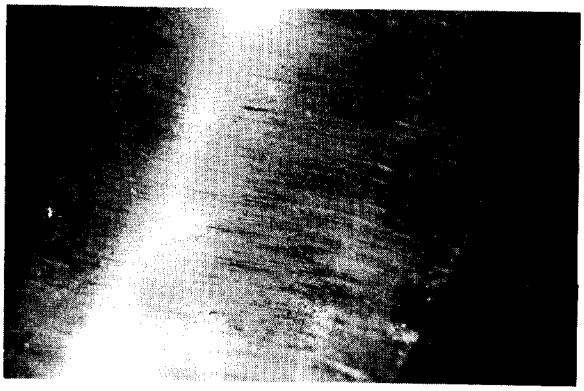


FIGURE 6

however, when cut encabochon with the long diameter of the stone at right angles to the fibrous layers, a pleasing chatoyant effect is created (Figure 5). A well-defined "eye" occasionally may be produced by skillful cutting, but the usual tiger's-eye is characterized by an asbestos-like waviness of fibers, creating several sets of chatoyant bands. Figure 6 shows this wavy fibrous structure. "Crocidolite" and "petrified wood" are names that are sometimes applied incorrectly to this mineral.

2. Hawk's-Eye, or Falcon's-Eye.

This material is a very close relative of tiger's-eye, but the original fibers of crocidolite have not been replaced completely by silica. As a consequence, hawk's-eye retains the original grayish-blue color of the crocidolite, and when oriented properly and cut en cabochon, results in a bluish chatoyant stone that is quite similar to tiger's-eye, except for color. This mineral also occurs either in a translucent or semitranslucent form.

3. Quartz Cat's-Eye (Figure 7).

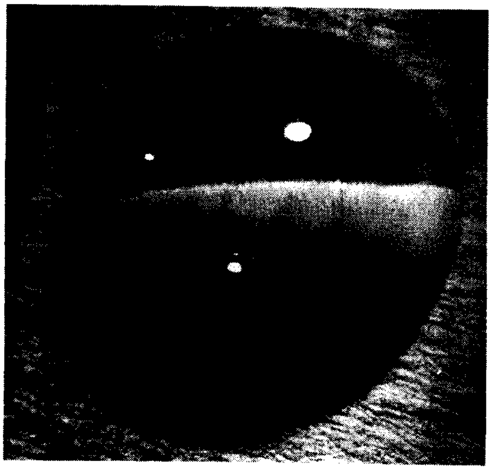


FIGURE 7

This variety is similar in appearance to tiger's-eye, except for its color and the sharpness of the chatoyant band in the finished stone. Cat's-eye is either translucent or semi-transparent and is found in colors ranging from white to gray-brown, greenish yellow, black, or light to dark olive green, although grayish is probably the most common. The finest material exhibits a narrow, well defined eye that rivals chrysoberyl in beauty and perfection. Some have been encountered in dealers' stocks labeled and priced as if they were chrysoberyl instead of quartz. The presence of many minute parallel fibers arranged throughout the stone at right angles to the "pupil" of the eye and parallel to the base of the stone are responsible for this unusually desirable effect. Quartz cat's-eye is also called Occidental cat's-eye, as distinguished from chrysoberyl, which is known correctly as Oriental cat's-eye.

4. Asteriated, or Star, Quartz.

Rose quartz and some grayish or milky quartz occasionally exhibit asterism; i.e., the ability under a concentrated light source to show a star effect. These stones are cut en cabochon for this purpose, but because of the usual faint appearance of the six-rayed star, they are frequently backed with a foil mirror to improve and accentuate their appearance. When viewed from the top, the star appears to be confined almost entirely to the surface of the stone, rather than emanating from the interior, as in star sapphires and rubies. When viewed from the side, parallel to the girdle place, the quartz stars appear almost colorless, because the enhanced depth of color caused by the usual colored foil backing is not apparent in this position.

III. MODE OF FORMATION.

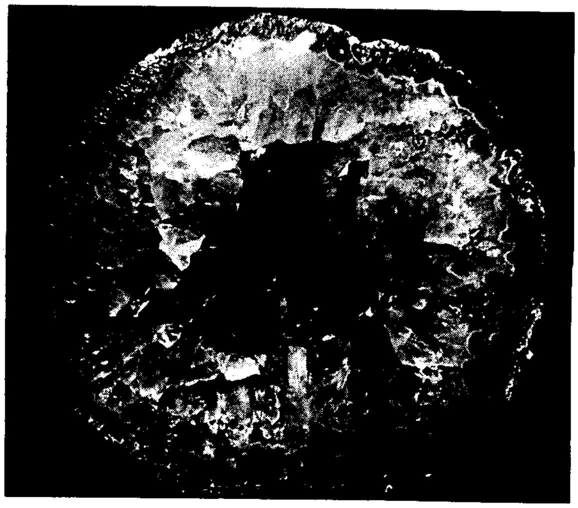


FIGURE 8

Quartz, the most common single mineral in the earth's crust, occurs in nearly every kind of rock and forms under a wide variety of conditions. It is an important constituent of granite, quartz diorite, pegmatites and a number of other igneous rocks. It is usually the last major mineral to crystallize in the cooling of a molten mass, so it is commonly without crystal faces in this occurrence. It is also common in many metamorphic rocks. It makes up the bulk of sandstones and is usually a key constituent of gravels. It is the most important vein-filling mineral where it may occur in a massive form or as well-formed crystals. As a foreign substance in limestones or shales, quartz may crystallize in cavities to form geodes lined with well-shaped crystals (Figure 8) or the cryptocrystalline chalcedony. Probably the bulk of gem quartz occurs in vein or geode deposits. Quartz, in one form or another, crystallizes under a wide range of temperatures and pressures, but it is usually regarded as representing the lower temperature and pressure end of the cooling and crystallization of an igneous mass (or the later emanations therefrom) or as a mineral deposited from cool solutions.

From the weathering and disintegration of such rocks, quartz is set free to be washed into streams and eventually into the ocean; thus, it is the principal constituent of gravel beds and beach sands. The frequently encountered term "rhinestone," which is commonly used today to describe foil-backed glass brilliants, owes its origin to the appearance of quantities of waterworn, tumbled pebbles of quartz carried down from the Alps to the lower channel of the Rhine River. When broken open, these cloudy, abraded pebbles were found to be completely transparent inside. They came to be known by the name "rheinkiesel," or "rhine quartz," and subsequently as rhinestone. In fact, varicolored glass imitations have found their way periodically into the trade, purporting to be "genuine rheinkiesel cut from brilliantly colored pebbles from the Rhine River Valley."

Rock crystal of a very high degree of purity has been synthesized and used in the manufacture of electronic equipment; however, because of the higher cost of production, it has not become a factor in the jewelry industry. It is difficult to imagine that, in view of the abundance of the genuine stone and its relatively low price, that synthetic quartz will ever become widely used in jewelry.

IV. SOURCES AND RECOVERY METHODS.

Rock crystal is very widely distributed in nature. The following sources have all produced significant quantities of high-quality material: Brazil, Switzerland, Hungary, Japan, India, Madagascar and the United States (principally Arkansas and New York). Brazil, in particular, has produced stones of exceptional quality that have been used extensively in optical and electronic equipment.

The principal sources of fine-quality amethyst include Brazil (chiefly from the States of Rio Grande do Sul and Bahia), the neighboring country of Uruguay, and the Ural Mountains of Russia. Other localities that have produced important quantities are Ceylon, Japan, Mexico, Transvaal (South Africa), United States, Madagascar and Persia (Iran). Geodes containing beautiful amethyst crystals have been found in many localities. One fabulous specimen, reported early in the twentieth century, was found in Rio Grande do Sul, Brazil; it measured thirty-three feet in length, five and one-half feet in breadth, and was estimated to weigh about thirty-five tons. The entire cavity was lined with brilliant, well-formed amethyst crystals of a deep bluish-violet color.

Important sources of citrine are relatively few, significant quantities of fine material being produced only by Brazil and Madagascar. Commercially unimportant sources include Uruguay, Russia (Ural Mountains), Spain, Hungary and the United States. The fact that heating of less attractive qualities of amethyst and smoky quartz will produce stones with reddish, yellowish, and orangy-brown tones probably has served to limit the production of citrine from its original sources.

Any discussion of smoky quartz, or cairngorm, naturally centers around its discovery in the Cairngorm Mountains of Scotland, and its extensive use there by the Scots in ornamenting their colorful native costumes. Indeed, it may be regarded as the "national gem" of that country. Although a source of historical and traditional interest to gemologists, other areas are actually more productive of smoky quartz than Scotland. Chief among the countries noted for important deposits of this mineral are Ceylon, Spain, Switzerland and the United States, particularly Maine, New Hampshire and the Pike's Peak region of Colorado.

Unlike some of the other popular varieties of quartz, rose quartz is not widely distributed. In addition to the major quartz sources of Brazil and Madagascar, the other countries that have produced this mineral in quantity include the United States (Maine and the Black Hills of South Dakota), Japan, India, South-West Africa, Russia, Germany and the Alps Mountains of Switzerland.

Reddish-brown aventurine quartz occurs most notably in Spain, Russia and India. However, the best-known material today is a compact, fine-quality green variety from India. This type is also available from Brazil and has been reported as being highly esteemed in China, although a source in that country seems, at best, doubtful. Various countries in Europe are reported to have been minor sources, but none seems to have produced significant quantities. Madagascar is also a possible source. Wyoming has produced appreciable quantities, often under the erroneous impression that it was nephrite jade.

There are few known sources of dumortierite quartz, and these lie entirely in the southwestern United States and in central Mexico in the State of San Luis Potosi. California, Nevada and Arizona all have contributed to the limited production of this variety.

Siderite is not used to any extent in the jewelry trade, and sources are not well established. Both Brazil and Germany have been producers.

The best quartz cat's-eyes are found in the gem gravels of Ceylon, and South Africa (Griqualand West) has long been noted for its tiger's-eye.

V. FASHIONING.

Quartz is fashioned in many forms and by a wide variety of methods, from the most primitive to the most advanced. Rock crystal has long been a favored material for beads, divining balls, statuary and other objects of art. It is used extensively in inexpensive rings, bracelets and many other forms of jewelry. Attractive five-pointed stars cut from this popular gem mineral are currently in vogue for use in earrings and pendants. When rock crystal is faceted, the brilliant-cut style is usually used. Citrine, cairngorm and amethyst are usually faceted in the step-, brilliant- or mixed-cut styles; the color is often intensified by deep cutting. The cabochon style is used for aventurine, rose quartz, cat's-eye and tiger's-eye. In addition, rose quartz finds favor as a material for carved ornamental and decorative pieces, some of which are outstanding for their pastel beauty. Tiger's-eye is most commonly carved in the form of cameos and intaglios for use in men's rings, cuff-links and similar items (Figure 9). Both rose quartz and tiger's-eye are popular for making tumbled, or baroque, stones, in which form they find wide application in earrings, dangle bracelets, pendants and other inexpensive but attractive pieces.

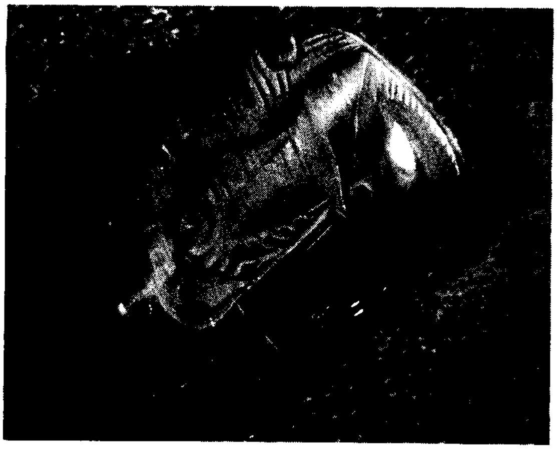
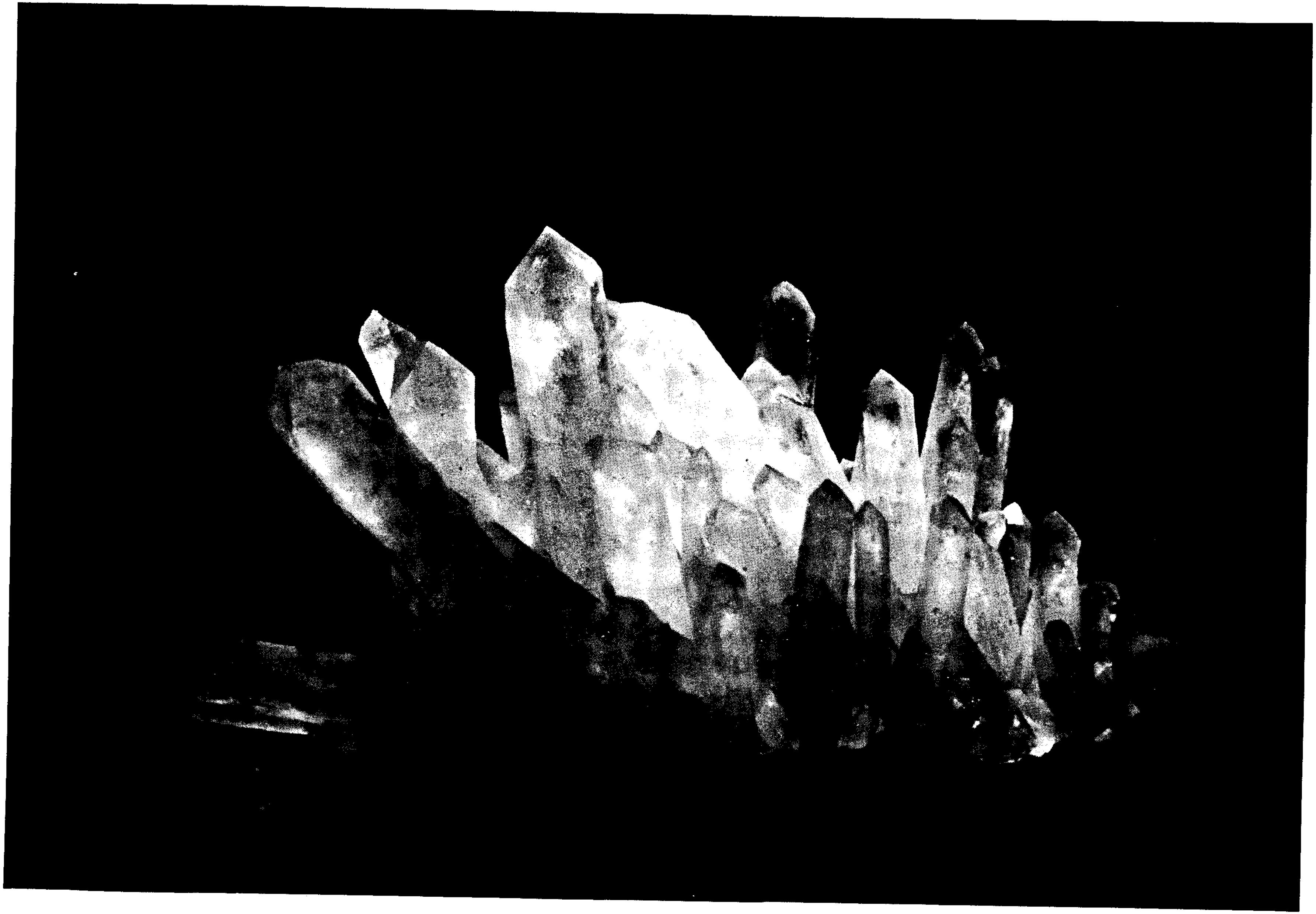


FIGURE 9

Since cleavage does not present a problem in the fashioning process, the transparent varieties of quartz need only to be oriented for color. If amethyst is unevenly colored, it should be oriented so that the most attractive color is located on the pavilion near the culet. Care should be exercised, however, because a too-deep color at this point in an already deeply colored stone will be accentuated and the entire stone might assume an undesirable "thick" color. Rutilated quartz should be oriented carefully for arrangement of the needles, if it is to be faceted. Orienting star quartz can be aided by the use of the polariscope. An alternate method is to grind a sphere or a rounded surface and use a wetting agent and a pinpoint source of light to locate the apex of the star.



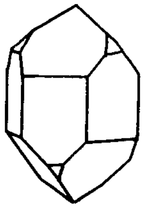
QUARTZ-CRYSTAL AGGREGATE

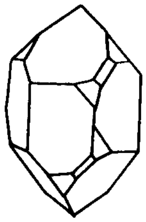
Since quartz is not heat sensitive, the usual care is sufficient in the dopping and sawing operations. Grinding cabochons of the crystalline quartz varieties is accomplished on a medium- to fine-grit carborundum wheel, and polishing is done on a felt lap with cerium or tin oxide. Tiger's-eye sometimes presents a problem because of undercutting; however, very fine sanding prior to polishing on a leather lap with Linde A or chromic oxide will give satisfactory results. Polishing faceted transparent varieties is done with cerium oxide or tin oxide on a tin or lucite lap. A crown angle of 42° and a pavilion angle of 43° is recommended.

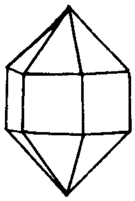
VI. PHYSICAL AND OPTICAL CHARACTERISTICS.

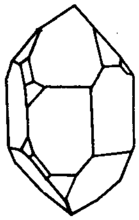
Physical

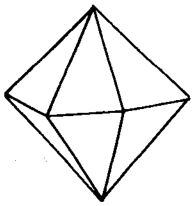
Chemical Composition	SiO_2; (silicon dioxide, or silica).
Crystallographic Character	Hexagonal system. The habit is prismatic. Crystals are usually attached at one end and terminated at the other end by a pair of rhombohedrons, giving a pyramidal appearance. Quartz often appears to belong to a high symmetry class of the hexagonal system, but actually the symmetry is trigonal, or threefold. What would appear to be normal prism and bipyramid faces occur in two sets of three, rather than in sets of six; thus, the terminations are rhombohedral faces. The deceptive appearance is often the result of a form of penetration twinning. Amethysts are often colored only in one of the pair of twins making up the whole. Some are colored in both, but the dichroic colors in the two portions are opposite. Another form of twinning accounts for the "herringbone" pattern on amethyst fractures, mentioned below. The prism faces are generally marked by numerous horizontal striations; i.e., at right angles to the C axis (usually the long dimension) of the prism faces. Adventurine and tiger's-eye are made up of small crystal grains and rose quartz is more coarsely crystalline; all of these are massive.











Hardness	7.
Toughness	Good.
Cleavage	None.
Fracture	Conchoidal in crystal forms, often with fine, parallel ridges imparting a "herringbone" pattern in amethyst and heat-treated citrine; uneven to splintery in massive types.
Specific Gravity	2.56 to 2.66, with slightly higher values possible for the massive varieties.
Streak	Colorless.
Characteristic Inclusions	Transparent varieties frequently show negative crystals in the usual hexagonal crystal form of quartz. Such cavities may contain liquid or gas bubbles. Sagenite contains elongated needles of rutile, tourmaline or other minerals. Asteriated varieties owe their appearance to the presence of small "bundles" of needle-like inclusions. Aventurescent types contain numerous tiny flakes or platelets of metallic minerals, usually hematite, goethite, fuchsite, or mica. Chatoyant stones exhibit fibrous inclusions, usually crocidolite in some state of pseudomorphic change from blue to the yellowish-brown color of tiger's-eye.

Optical

Degree of Transparency	Transparent to opaque; thin sections of opaque stones are translucent.
Luster	Vitreous, both on polished stones and fractured surfaces.
Refractive Index	1.544-1.553 (doubly refractive). The R.I. of quartz shows almost no variation from these values.
Birefringence	.009. Also a very constant value.
Optic Character	Uniaxial positive.
Pleochroism	Amethyst: weak to distinct violet or purple and gray-violet. Citrine: very weak light yellow and very light yellow. Smoky quartz: weak brown and

	reddish brown in dark stones; light and darker yellow-brown in lighter stones. Rose quartz: colorless and very weak light red.
Dispersion	.013.
Phenomena	Chatoyancy: tiger's-eye, hawk's-eye and cat's-eye. Asterism: rose quartz. Aventurescence: aventurine quartz. Iridescence: iris quartz.
X-ray Fluorescence	Rose quartz exhibits a faint bluish-violet glow. All other varieties are inert.
Transparency to X-rays	Translucent.
Ultraviolet Fluorescence	Rose quartz: pale purple under short wavelength. Aventurine: the greenish variety shows a grayish-green glow under both long and short wavelengths. All others are inert.
Color-Filter Reaction	None.
Absorption Spectra (Hand Spectroscope)	Aventurine: the greenish variety shows bands at approximately 6820 and 6490 A.U., which are probably due to mica inclusions. None of the other varieties have distinguishing characteristics.

Effects Caused by:

Heat	Strong heating renders amethyst, citrine, smoky quartz and rose quartz colorless; however, gentle heating may improve the color of amethyst. Slightly higher temperatures are used frequently on poorer qualities of both amethyst and smoky quartz to produce yellowish, brownish or reddish-orange stones that are marketed as citrine. Each stage of the heat treatment is permanent. Some Brazilian amethysts that have been changed to a green color have been marketed as "praseolite" or "greened amethyst." Quartz is infusible before the blowpipe. Quenching after repair work should be avoided.
Acids	Soluble in hydrofluoric acid and very slightly soluble in alkalies.

Irradiation Irradiation of colorless heat-treated quartz is reported to produce color; however, the restored color will not necessarily be the same as the original. The color of smoky quartz is theorized to have been produced by the action of underground radioactivity on rock-crystal deposits. Other investigations indicate that the color of amethyst may be due partially to exposure to radioactivity.

VII. SUGGESTIONS FOR TESTING.

Basically, crystalline quartz in the form cut from single crystals should offer no serious problems in identification under ordinary circumstances. The only difficulty the novice tester is likely to encounter is that caused by the multiplicity of varieties in which quartz occurs. With the exception of blue, it is common in a transparent form in almost all pastel colors, as well as in dark tones of purple, violet, brown and yellow. Some heat-treated green stones exist, and occasionally rough-backed dark-blue stones are encountered that have been coated or treated with a dye on the rough portion.

All of these transparent stones are characterized by refractive indices of 1.544-1.553, of which the lower is constant and the higher varies from 1.544 to the high figure of 1.553. The specific gravity is always between 2.65 and 2.66. A liquid with a density of 2.62 separates chalcedonic quartz from crystalline quartz readily, since chalecedony will float and crystalline quartz will sink. Another characteristic of single-crystal quartz is apparent in the polariscope when an interference figure is obtained. Uniaxial quartz displays a figure that is unique among gemstones, in that the black brushes at right angles to one another extend only to the innermost ring of the interference figure. The remainder of the figure (i.e., the center ring) is a single color; this is caused by the rotational polarization that quartz imparts to light passing through parallel to the optic axis. Ordinarily, quartz shows no cleavage, and its conchoidal fractures usually possess a vitreous or subvitreous luster. The fracture surfaces may show a series of tiny, parallel ridges.

Quartz is distinguished very readily from most of the gemstones that resemble it in one or more colors. Refractive index alone will distinguish it from topaz, sapphire and most other stones, but the polariscope may need to be employed to distinguish quartz from glass. Green aventurine is often mistaken for either nephrite or jadeite, but its low R.I. and S.G. make it simple to distinguish it from either of the two jades. Frequently, prospectors who find a deposit of green quartz have it tested by a chemist and discover that the elements included are those expected in jadeite or nephrite. As a result, despite differences in physical properties, aventurine quartz is sometimes identified as jade. Such an error is usually occasioned by a spectrographic analysis in which traces of sodium and aluminum are indicated. The fact that sodium and aluminum are essential constituents of jadeite may lead the uninitiated to a gross error of this kind. This happens most frequently with green jasper, which contains a considerable quantity of impurities.

During World War II, when synthetic sapphires and rubies were difficult to obtain, some ring manufactureres used sapphire imitations made by roughening the backs of star-quartz cabochons and treating them with a deep-blue substance to simulate the appearance of sapphire. This material was detectable by a spot R.I. reading and careful examination.

The finest quartz cat's-eye has the appearance that one associates with rather fine-quality chrysoberyl cat's-eye, but its much lower properties make it readily distinguishable from the so-called precious cat's-eye.

VIII. EVALUATION.

Practically all varieties of quartz are fairly common. Most jewelers are unaware of the great size in which many of them occur. For instance, it is not particularly difficult to obtain a 1000-carat rock crystal, a 250-carat amethyst, a 500-carat citrine, or a tiger's-eye the size of a silver dollar. In addition, when such stones exceed the sizes that can be worn in jewelry, their per carat value decreases materially.

Dyed (crackled) quartz is most often encountered in a red color, since it is produced primarily to fill out the color range of quartz. However, it may also be produced in other colors.

Gold-quartz gems are made by cutting portions of milky quartz containing inclusions of native gold. These stones are generally priced according to the value of the gold they appear to contain and the attractiveness of its distribution, since they would have virtually no value otherwise.

Star-quartz stones with foil backs are inexpensive substitutes for star sapphires. But quartz from certain areas is so strongly asteriated that it does not need a foil backing to exhibit a star and may therefore be confused with star sapphires. Pink is the most common and the least expensive of the quartz foilbacks. Other colors include red, brown, yellow, orange and green, which are priced according to their resemblance to star sapphires. Tiger's-eye is found naturally in a yellow to brown color. However, it may be heat treated to change it to a dark brown or red-brown, dyed to make it any color, or treated with acid to make it almost colorless. All colors are equally inexpensive and may be obtained in almost unlimited quantity.

Quartz cat's-eye is very similar in appearance to chrysoberyl cat's-eye; in fact, it is often encountered under the name cat's-eye. It occurs in yellow, brown, blue, green and black. Pricing is in direct ratio to its resemblance to the chrysoberyl variety.

Semitranslucent, solid-green aventurine containing abundant spangles of mica is the most popular and valuable. The best qualities are sold in China. "Goldstone," the glass imitation of brown aventurine, is more in demand in America than the genuine green material.

IX. BUYING AND SALES ASPECTS.

Quartz varieties are available in such quantity and at such low prices that people of almost any income level are prospects for colored-stone jewelry set with quartz. The finest amethyst is one of the most cherished of gemstones, despite its low price. The finer qualities of citrine are available in quantity at even lower prices, and the same is true of the excellent jade imitation furnished by aventurine. The interesting and colorful tiger's-eye is likewise very inexpensive.

As an initial step in the exploitation of the tremendous and almost universal interest of the public in colored stones, the quartz varieties offer real potentialities. Most of them are available at prices less than those asked for synthetic ruby, sapphire and other synthetics and imitations, and they have the great advantage of being genuine. One effective method of creating interest is to set up one or more windows in which quartz-set jewelry and rough and cut stones are displayed. Prominent price tags demonstrate clearly the low price range. Thus, the display serves to attract attention and to reduce door resistance by featuring beautiful merchandise at low prices. It does not require much selling to convince the average customer of the desirability of possessing the genuine rather than the synthetic or imitation. Add this factor to the attractive price range in which quartz is available and the beauty it offers and quartz gems are obviously highly saleable in the right hands.

In addition to the beauty that is inherent in many of the quartz varieties, its long use by mankind has built up so many legends and superstitions that a capable colored-stone salesman can establish a many-pronged appeal for any quartz gem he features. For example, the fascinating legendary aspects of amethyst and its supposed power to prevent intoxication may be exploited effectively. The collecting of amethyst by many of the famous royal figures of the past is also of interest.